Center Innovation Fund: JSC CIF

SHAPE: Shape Memory for a High Turn-Down Ratio

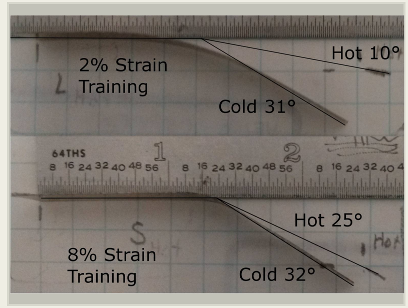
Completed Technology Project (2013 - 2013)

Project Introduction

Spacecraft designed for missions beyond low earth orbit (LEO) face a difficult thermal control challenge: they are required to reject a high heat load to warm orbital environments and a low heat load to cold transit environments, necessitating a quite high turn-down ratio. This difficult challenge can be transformed into a tractable design problem for arbitrarily high turn-down ratios through the use of shape memory alloys, materials that exhibit a temperature dependent phase change such that they can be easily deformed below the transition and recover a predefined shape above the transition. In fact, shape memory alloys can be trained to behave in a two-way manner so that it takes one shape above and another below the transition temperature. Such materials make possible a passively deployed heat rejection device which adjusts vehicle and environment loads based on its operating temperature alone. This project seeks to train a shape memory material and evaluate its behavior. This project trained a shape memory material to behave in a two-way manner and evaluated the capability of the two-way shape memory effect. A literature review identified an optimum training method involving alternating constrained and unconstrained thermal cycles. The effect of two bending strain rates were investigated through training rigs of differing radii, both trained in parallel. It was identified that in both cases cold working of the material results in some deformation to the austinite shape. This cold work deformation can be addressed through careful design of the hot set shape of the material.The results indicate that the greatest delta between austinite and martensite shapes is obtained through the lesser training strain (large radius rig). Projection of the results of two-way training of the material indicate that sufficient deformation can be trained to successfully employ in a full sized heat rejection device.

Anticipated Benefits

This technology promises an elegant variable heat rejection system that can be employed in vehicle thermal control systems to improve turn-down, enable single-loop thermal control, and to do so without additional controls, instrumentation, or power requirements.



Project Image SHAPE: Shape Memory for a High Turn-Down Ratio

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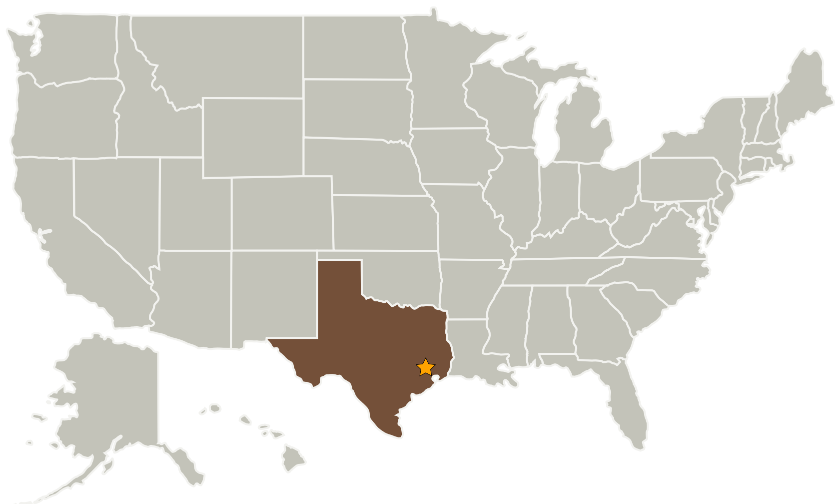
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas

Primary U.S. Work Locations
Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Carlos H Westhelle

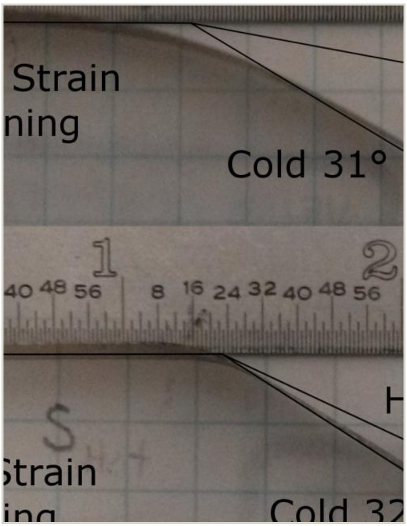
Project Manager:

Thomas J Cognata

Principal Investigator:

Thomas J Cognata

Images



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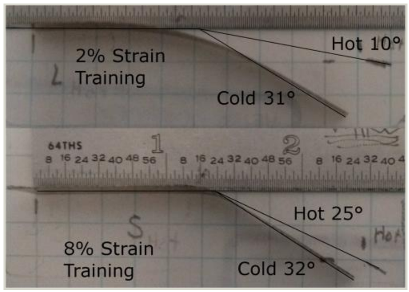
Project Image SHAPE: Shape Memory for a High Turn-Down Ratio
(https://techport.nasa.gov/image/2230)



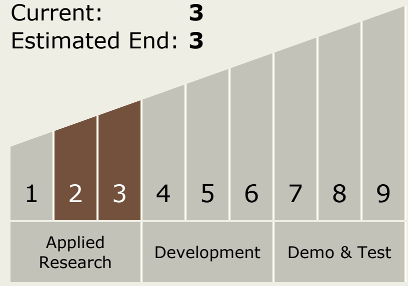
12136-1376957466131.jpg
Project Image SHAPE: Shape Memory for a High Turn-Down Ratio
(https://techport.nasa.gov/image/2232)

Links

NTR 1
(http://MSC-25697-1)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.1 Materials
    └ TX12.1.8 Smart Materials